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Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
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Method for compressing/decompressing video information

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"Method for compressing/decompressing video information"

FIELD OF THE INVENTION

The present invention relates to a method for compressing/decompressing video information, and to corresponding compressing and decompressing devices. It also relates to a computer program product for carrying out said method, and compressed data obtained by implementation of said method.

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BACKGROUND OF THE INVENTION

The current standards belong to the MPEG family like MPEG-1, MPEG-2 and MPEG-4 (see for instance MPEG-4 Visual coding standard ISO/IEC 14496-2, document available at ISO, referred here under the MPEG-4 document number w3056) and to the ITU H.26X family like H.261, H.263 and extensions, and H.264.

Most video coding standards take advantage of the fact that there are some redundancies between subsequent frames of a video sequence. In most video compression algorithms, each frame is subdivided into segments. The segments can be regular square blocks as in MPEG-4, square or rectangular blocks as in H.264. When decompressing the compressed data, each segment of a following frame is obtained by calculation of a prediction based on a corresponding segment of a previous frame by using motion information generally called motion vector, and correction or residual information generally called residual image defining the differences between the segment and its prediction and more generally between the frame and its prediction. The compression standards provide a way of encoding the motion information and the correction information for retrieving a following frame based on a previous known frame.

Mainly, two approaches are used by the compression standards. A first approach is named the backward approach. It is implemented in MPEG and ITU H.26X standards. In the backward approach, for each segment of a following frame, the compression method tries to find the segment of the previous frame that is the closest to it or at least less far from it. This may cause problems for segments that appear in the following frame and not in the previous frame. Still, for any segment that is present in both the previous and the following frames, this system gives the best prediction, for a given motion model, providing a full search of the motion parameters is done, that is to say that any possible parameters are considered. The problem with the backward approach is that, in many cases, the used frame segmentation

does not coincide with the frame segmentation into "real" objects that may have different overall motions.

The second approach is named the forward approach. This approach is disclosed for example in WO-00/64167. It uses a segmentation based coding scheme using "real" objects of the frame. In the forward approach, for each segment of a previous frame, which is considered as an independent object, the best match is searched in the following frame, that is to say the method tries to find what the object became between the two frames. The segments of the following frames that are predicted are not optimally predicted with regard to the considered motion model. It is not sure to have the best possible prediction of the following frame from the previous frame, even with full search motion estimation. Indeed the optimisation is performed regarding what one has, i.e. the previous frames, and not regarding what one wants to have, i.e. the new frame.

SUMMARY OF THE INVENTION

It is therefore the object of the invention to provide a video compression method - and an associated decompression method - that enables to optimise the segmentation used for the prediction of a following frame based on a known previous frame.

To this end, the invention relates to a method for compressing video information in a video sequence (I_t, I_{t+1}) comprising the steps of :

. considering in said sequence a first video frame (B_t) containing image data ;

. segmenting said first video frame (B_t) into segments ($S_{t,i}$) ;

. for each segment ($S_{t,i}$) of the first video frame (B_t) :

- searching, in a second video frame (I_{t+1}) following the first video frame (B_t) in the video sequence, a corresponding predicted segment ($S^{p,forward}_{t+1,i}$) which matches with the segment ($S_{t,i}$) of the first video frame (B_t) according to a predetermined similarity measure ;

- calculating a raw set of motion parameters ($M^p_{t,i}$) describing the motion between the segment ($S_{t,i}$) of the first video frame (B_t) and the corresponding predicted segment ($S^{p,forward}_{t+1,i}$) of said second video frame (I_{t+1}) ; and

. for each corresponding predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}):

- searching, in the first video frame (B_t), a corresponding segment ($S_{t,i}^{p,backward}$) that matches with the predicted segment ($S_{t+1,i}^{p,forward}$) of the second video frame (I_{t+1}) according to a predetermined similarity measure ;

- calculating a best set of motion parameters ($M_{t,i}^p$ + $\Delta M_{t,i}^p$) describing the motion between the corresponding segment ($S_{t,i}^{p,backward}$) of the first video frame (B_t) and the predicted segment ($S_{t+1,i}^{p,forward}$) of the second video frame (I_{t+1}), said best set of motion parameters consisting in the raw set of motion parameters ($M_{t,i}^p$) corrected by a motion parameters correction ($\Delta M_{t,i}^p$).

As seen later in the description, such a method has the advantage to provide a segmentation of the following frame which is optimised before applying a backward approach to determine the best set of motion parameters.

Additional features are recited in the sub-claims 2-8.

Another object of the invention is to propose a method for decompressing video information in a video sequence as defined in claims 9-12.

It also concerns a computer program product as in claim 13.

In addition, there is provided an encoder for compressing a sequence of frames and a decoder for decompressing video information as defined in claims 14 and 15, respectively.

It also concerns compressed data corresponding to a video sequence as defined in claim 16.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be now described, by way of example, with reference to the accompanying drawings in which :

- Figure 1 is a schematic view of a typical processing chain for a video sequence made of successive frames ;

- Figure 2 is a flow chart showing the video compression algorithm of the method for encoding a sequence of frames according to the invention ;

- Figure 3 is a schematic view of a processed frame at successive steps during the compression operation ;

- Figure 4 is a flow chart showing the video decompression algorithm of the method for decoding the compressed data corresponding to the compression method of a sequence of frames according to the invention ; and

- Figure 5 is a schematic view of a processed frame at successive steps during the decompression operation.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 shows a typical processing chain for a video sequence made of successive frames, each frame containing image data. This chain includes an encoder 12 adapted to receive a sequence of frames. These frames, provided for example by a digital camera, are arrays of pixels, each pixel being characterized by color parameters, which can be chrominance and luminance or Red, Green and Blue values for example. In the following, the t^{th} frame of an input sequence is denoted I_t.

The encoder 12 is adapted to implement a video compression method according to the invention and to output encoded data that are compressed. The compression method takes advantage of the fact that there are some redundancies between subsequent frames of the video sequence. The encoded data are then stored in a support like a tape or are transmitted over a medium like a wireless network. The processing chain finally comprises a decoder 14 that is adapted to decompress the encoded data and to provide a sequence of frames. The decoder 14 is adapted to implement a video decompression method according to the invention. In the following, the t^{th} frame of a decompressed sequence is denoted B_t.

Figure 2 shows the video compression algorithm carried out in the encoder 12. Figure 3 shows the following processed frames during the implementation of the compression algorithm. This algorithm of Figure 2, implemented by a processing unit like a DSP driven by an adapted software program, is repeated for each frame of the sequence of frames to be encoded. The steps shown in Figure 2 concern the encoding of frame I_{t+1}. It is assumed that the previous frame I_t has already been encoded and that the decompressed frame B_t corresponding to frame I_t is known.

Roughly, the method consists in two main stages. In a first stage 200, a first set of motion parameters is defined by using a forward approach to project segments of the previous frame I_t in order to predict the following frame I_{t+1}. . Once projected, a predicted segmentation of the following frame I_{t+1} is provided. This segmentation is more likely to coincide with real objects of the following frame I_{t+1} than an arbitrary segmentation, a grid of blocks for example. Without considering the "holes" of the predicted segmentation as segments (they are not predicted by any part of the frame I_t), for each projected segment, a corresponding segment called a predicted segment is provided in the prediction, and above all, a set of motion parameters. In order to refine the prediction if necessary, a new motion

estimation is performed in a second stage 201, this time by using the backward approach on the predicted segments.

The first stage 200 is based on a forward approach, which means that segments of the previous frame I_t are searched in the following frame I_{t+1}. The compression method will now be disclosed in details.

At step 202, a segmentation of decompressed frame B_t is defined and stored. The segmentation of B_t consists in defining a subdivision of B_t into segments $S_{t,i}$. A set of segmentation parameters is determined. It defines the segmentation process that is implemented. Advantageously, the segment boundaries coincide with object boundaries in the frame B_t. Thus, the segments are "real" objects in the picture corresponding to frame B_t. In the following, all the segments $S_{t,i}$ are processed subsequently. Thus, a segment $S_{t,i}$ is considered in B_t at step 204.

At step 206, a corresponding segment $S^{ref}_{t+1,i}$ is searched in the following frame I_{t+1} to be encoded. The corresponding segment $S^{ref}_{t+1,i}$ is the segment of frame I_{t+1} which provides the best match with segment $S_{t,i}$ according to a given similarity measure. The similarity measures are known per se and will not be disclosed.

At step 208, some parameters that enable to retrieve $S^{ref}_{t+1,i}$ are stored. In particular a raw set of motion parameters $M^p_{t,i}$ is calculated. These motion parameters define the changes in the position of $S^{ref}_{t+1,i}$ with respect to $S_{t,i}$. For example, the set of motion parameters $M^p_{t,i}$ defines a translational motion.

According to the forward approach, the predicted segment denoted $S^{p,forward}_{t+1,i}$ and the raw set of motion parameters $M^p_{t,i}$ are defined as follows :

$S^{p,forward}_{t+1,i} = MC(S_{t,i}, M^p_{t,i})$, where $MC(S_{t,i}, M^p_{t,i})$ is the motion compensation operation using $M^p_{t,i}$ as motion parameters ;

$$M^p_{t,i} = \underset{M \text{ in motion search range}}{\arg\min} \left(diff\left(MC(S_{t,i}, M), S^{ref}_{t+1,i,M}\right)\right) \quad \text{(for example)} \ ;$$

where $S^{ref}_{t+1,i,M}$ is the segment of the following frame I_{t+1} that coincides with $MC(S^{ref}_{t,i}, M)$ and diff(a,b) measures the similarity of a and b (the higher the measure, the less a and b are alike

– it can be, for example, the sum of square differences of the pixel color values over the whole segment) ;

$S_{t+1,i}^{p,forward}$ is a raw predicted segment.

At this step, no processing is done to deal with overlapping between the different predicted segments $S_{t+1,i}^{p,forward}$. The overlapping issues are dealt with as disclosed below. Steps 202-208 are repeated until all the segments $S_{t,i}$ of previous decompressed frame B_t are considered. Thus, for each segment $S_{t,i}$, a corresponding predicted segment $S_{t+1,i}^{p,forward}$ is defined in the prediction together with a raw set of motion parameters $M_{t,i}^{p}$ called forward motion parameters.

Once every segment of the previous decompressed frame B_t is projected, some raw predicted segments may overlap each other. Some decisions is made at step 210 for solving the intersection between adjacent segments. Thus, overlapping parameters are calculated. According to a first embodiment, it is determined which segment is in front of which. How to make these decisions is not within the scope of the present invention. When it is done, predicted segments have their final shape, i.e. the original shape minus the possibly hidden parts. According to another embodiment, a merge parameter α is determined for each pair of adjacent segments. For each pixel of the intersection between the adjacent segments, a value of the pixel $P_{overlap}$ is defined by : $P_{overlap} = \alpha P_{segment1} + (1 - \alpha) P_{segment2}$, where $P_{segment1}$ and $P_{segment2}$ are the values of the corresponding overlapping pixels of both segments.

The prediction of the following frame I_{t+1} resulting from the set of predicted segments $S_{t+1,i}^{p,forward}$ may have holes. These holes correspond to newly uncovered parts of the following frame I_{t+1}. The holes are considered as new predicted segments or their contents are stored at step 212. Holes processing is not within the scope of the invention. In a possible embodiment, holes are added to the projected segmentation as new segments to be processed in the next step of the algorithm. They could also be merged with an existing predicted segment, or simply be stored as holes to be processed after motion processing was done. In any case, information regarding holes is encoded and stored. After step 212, a set of $S_{t+1,i}^{p,predicted}$ segments that corresponds to the set of $S_{t+1,i}^{p,forward}$ segments after having been processed for holes and overlapping is defined. At step 213, it is decided whether a calculation of a new best set of motion parameters by using a backward approach is necessary. If it is necessary, the second stage 201 is performed and a corresponding flag [YES] is memorized. If not, a

corresponding flag [NO] is memorized and step 220 is directly performed for calculating residual frame R_{t+1} as will be disclosed below.

If necessary, a new motion estimation is performed in the second stage 201, by using a backward approach based on the predicted segments $S_{t+1,i}^{p,predicted}$. At step 214, a predicted segment $S_{t+1,i}^{p,predicted}$ as provided by the forward approach is considered. At step 216, a search is carried out in the previous frame B_t to find the segment of frame B_t denoted $S_{t,i}^{p,backward}$ that is the closest to the considered predicted segment $S_{t+1,i}^{p,predicted}$ according to the given similarity measure. At step 218, the new best set of motion parameters denoted $M_{t,i}^{p} + \Delta M_{t,i}^{p}$ is calculated. $\Delta M_{t,i}^{p}$ is a motion parameters correction such that $M_{t,i}^{p} + \Delta M_{t,i}^{p}$ defines the motion from $S_{t,i}^{p,backward}$ to $S_{t+1,i}^{p,predicted}$. The new best prediction for $S_{t,i}^{p,backward}$ is searched in a small area around the segment defined by applying the forward motion parameters $M_{t,i}^{p}$ to the predicted segment $S_{t+1,i}^{p,predicted}$. Steps 214-218 are repeated until all the predicted segments $S_{t+1,i}^{p,predicted}$ are considered. At this point, remaining holes are processed.

At step 220, a residual frame R_{t+1} is computed and encoded. The encoding method is not within the scope of this invention. In a possible embodiment, residual frame R_{t+1} may be encoded on a segment basis using the projected segmentation ($S_{t+1,i}^{p,predicted}$ and holes). The residual frame R_{t+1} defines the structural differences between the image prediction $B_{t+1}^{predicted}$ (the reunion of all predicted segments $S_{t+1,i}^{p,predicted}$ and processed holes) and the predicted image I_{t+1}. According to the invention, the best set of motion parameters $M_{t,i}^{p} + \Delta M_{t,i}^{p}$ is stored with a multi-layer motion description. The first layer contains the raw set of motion parameters $M_{t,i}^{p}$ and the flag [YES] or [NO] indicating if the decoder 14 should wait for an additional layer. The second layer contains the motion parameters correction $\Delta M_{t,i}^{p}$. At the end of the compression method, the compressed data provided by the encoder 12 are the segmentation parameters, the motion parameters $M_{t,i}^{p}$ or the best set of motion parameters $M_{t,i}^{p} + \Delta M_{t,i}^{p}$ of each segment contained in the multi-layer motion description, the overlapping information, the holes information and the residual frame R_{t+1}.

Upon reception of the compressed data, the decoder 14 applies the algorithm disclosed on Figure 4. Figure 5 shows the processed frames during the implementation of the decompression method. The same algorithm is repeated for each frame B_{t+1} to be

decompressed. It is assumed that a previously decoded frame B_t is known and that the following frame B_{t+1} has to be decompressed.

At step 402, frame B_t is segmented based on the set of segmentation parameters by using the same algorithm and the same settings as its counter part B_t at the decoder side. These settings are set once and for all or are transmitted with encoded frames. The segments of B_t are denoted $S_{t,i}$ for clarity reason. A segment $S_{t,i}$ of B_t is considered at step 404 and the first layer motion parameters $M^p_{t,i}$ of segment $S_{t,i}$ are decoded and applied at step 406. A predicted segment $S^p_{t+1,i}$ is obtained. Steps 404-406 are carried out for all the segments of the decompressed frame B_t.

Overlapping parameters are decoded and applied at step 408 to segment $S^p_{t+1,i}$ to obtain a new segment denoted $S^{p,o}_{t+1,i}$. Since the reunion of the segments $S^{p,o}_{t+1,i}$ may not cover the all frame, -the holes of B_{t+1} are predicted according to hole information contained in the compressed data, at step 410. Then, it is checked in step 412, if the flag contained in the first layer of the motion description indicates that additional motion information is contained in the second layer. If no additional motion information is contained in the compressed data, residual frame decoding is directly performed. A following predicted frame is defined by all the segments $S^{p,o}_{t+1,i}$. At this point, hole filing is performed, defining a predicted frame B^{pred}_{t+1}. Residual frame R_{t+1} is decoded and applied to the predicted frame B^{pred}_{t+1} to compute the final decoded frame B_{t+1}, at step 414.

If additional motion information is contained in the compressed data, at step 415 motion parameters correction $\Delta M^p_{t,i}$ is decoded and a corresponding improved segment $S^b_{t,i}$ is retrieved in the decoded frame B_t at step 416. This corresponding improved segment $S^b_{t,i}$ is the segment of B_t which would be projected on segment $S^{p,o}_{t+1,i}$ if the corrected motion parameters $M^p_{t,i} + \Delta M^p_{t,i}$ were applied to it. The corrected motion parameters $M^p_{t,i} + \Delta M^p_{t,i}$ are the raw set of motion parameters $M^p_{t,i}$ corrected by the motion parameters correction $\Delta M^p_{t,i}$. At step 417, the projection of $S^b_{t,i}$ using $M^p_{t,i} + \Delta M^p_{t,i}$ provides a corrected predicted segment $S^{p,o,c}_{t+1,i}$. A following corrected predicted frame is defined by all the segments $S^{p,o,c}_{t+1,i}$. At this point, hole filling is performed, defining a final corrected predicted frame B^{pred}_{t+1}. Then the residual frame R_{t+1} is decoded and applied to the final corrected predicted frame B^{pred}_{t+1}, at step 418 to provide the final decoded frame B_{t+1}.

Advantageously, according to a particular embodiment for a given segment, a motion vector is defined. This motion vector contains the first and second layers of the motion description. The forward motion parameters are the integer part of this vector. The predicted segmentation $S^{p}_{t+1,i}$ is computed according to this truncated motion information contained in the vector by only considering the integer part.

For the backward motion correction of each predicted segment $S^{p,o}_{t+1,i}$, the full precision vector is used. In this case, there is only one actual layer of motion parameters : backward and forward motions are contained in one motion symbol. Still, the motion description is two-layered.

In the previous embodiment, calculation of overlapping parameters at step 210 and the corresponding step 408 are performed for a predicted frame B_{t+1}, after all the segments have been predicted. According to an alternative embodiment, overlapping parameters are calculated for each segment after step 208. Thus, they are calculated and encoded segment by segment. Accordingly, the overlapping parameters are applied segment by segment just after step 406 in the decompression method.

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CLAIMS

1. A method for compressing video information in a video sequence (I_t, I_{t+1}) comprising the steps of :

. considering in said sequence a first video frame (B_t) containing image data ;

. segmenting said first video frame (B_t) into segments ($S_{t,i}$) ;

. for each segment ($S_{t,i}$) of the first video frame (B_t) :

- searching, in a second video frame (I_{t+1}) following the first video frame (B_t) in the video sequence, a corresponding predicted segment ($S^{p,forward}_{t+1,i}$) which matches with the segment ($S_{t,i}$) of the first video frame (B_t) according to a predetermined similarity measure ;

- calculating a raw set of motion parameters ($M^p_{t,i}$) describing the motion between the segment ($S_{t,i}$) of the first video frame (B_t) and the corresponding predicted segment ($S^{p,forward}_{t+1,i}$) of said second video frame (I_{t+1}) ; and

. for each corresponding predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}):

- searching, in the first video frame (B_t), a corresponding segment ($S^{p,backward}_{t,i}$) that matches with the predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}) according to a predetermined similarity measure ;

- calculating a best set of motion parameters ($M^p_{t,i} + \Delta M^p_{t,i}$) describing the motion between the corresponding segment ($S^{p,backward}_{t,i}$) of the first video frame (B_t) and the predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}), said best set of motion parameters consisting in the raw set of motion parameters ($M^p_{t,i}$) corrected by a motion parameters correction ($\Delta M^p_{t,i}$).

2. A method according to claim 1, characterized in that it includes a step of calculating a residual frame (R_{t+1}) for the second video frame (I_{t+1}) describing the structural differences between the first video frame (B_t) and the second video frame (I_{t+1}).

3. A method according to any one of claims 1 and 2, characterized in that it includes a step of calculating a set of overlapping parameters for each predicted segment ($S^{p,forward}_{t+1,i}$) resolving the intersections between said predicted segment ($S^{p,forward}_{t+1,i}$) and adjacent other predicted segments of the second video frame (I_{t+1}).

4. A method according to any one of claims 1 and 2, characterized in that it includes a step of calculating, for each video frame (B_{t+1}), a set of overlapping parameters resolving the intersections between the predicted segments of the second video frame (I_{t+1}).

5. A method according to any one of claims 1 and 2, characterized in that the first video frame (B_t) is a decompressed video frame corresponding to a frame (I_t) of the video sequence processed by said compression method and the corresponding decompression method.

6. A method according to any one of the preceding claims, characterized in that the best set of motion parameters ($M^p_{t,i} + \Delta M^p_{t,i}$) is defined according to a multi-layer motion description in which a first layer contains the raw set of motion parameters ($M^p_{t,i}$) and a second layer contains the motion parameters correction ($\Delta M^p_{t,i}$), the information of the first and second layers being distinguished.

7. A method according to claim 6, characterized in that it includes a step of setting a flag to a first or a second predetermined value indicating whether the motion parameters correction ($\Delta M^p_{t,i}$) has to be used for the video information decompression.

8. A method according to any one of the preceding claims, characterized in that it includes a step of determining a set of segmentation parameters defining the segmentation process implemented for segmenting the first video frame (B_t) into segments ($S_{t,i}$).

9. A method for decompressing video information in a video sequence (I_t, I_{t+1}) comprising :

. considering a first video frame (B_t) containing image data;

. segmenting said first video frame (B_t) into segments ($S_{t,i}$);

. for each segment ($S_{t,i}$) of the first video frame (B_t), defining a projected segment ($S^p_{t+1,i}$) by applying to the segment ($S_{t,i}$) of the first video frame (B_t), a raw set of motion parameters ($M^p_{t,i}$) describing the motion between the segment ($S_{t,i}$) of the first video frame (B_t) and the corresponding projected segment ($S^p_{t+1,i}$) and

. for each corresponding projected segment ($S^p_{t+1,i}$):

- finding in the first video frame (B_t) a corresponding improved segment ($S^b_{t,i}$) using both the raw set of motion parameters ($M^p_{t,i}$) and a motion parameters correction ($\Delta M^p_{t,i}$), the corresponding improved segment ($S^b_{t,i}$) being the segment of the first video frame (B_t) that would be projected on the corresponding projected

segment ($S^{p}_{t+1,i}$) by applying to it the raw set of motion parameters ($M^{p}_{t,i}$) corrected by the motion parameters correction ($\Delta M^{p}_{t,i}$) ; and

- defining a corrected projected segment ($S^{p,o,c}_{t+1,i}$) by applying the raw set of motion parameters ($M^{p}_{t,i}$) corrected by the motion parameters correction ($\Delta M^{p}_{t,i}$) to the corresponding improved segment ($S^{b}_{t,i}$).

10. A method according to claim 9, characterized in that it includes the steps of:

- considering a flag in the video information ; and
- calculating a corrected projected segment ($S^{p,o,c}_{t+1,i}$) by applying the raw set of motion parameters ($M^{p}_{t,i}$) corrected by the motion parameters correction ($\Delta M^{p}_{t,i}$) to the corresponding improved segment ($S^{b}_{t,i}$) if said flag has a first predetermined value and not calculating a corrected projected segment ($S^{p,o,c}_{t+1,i}$) if said flag has a second predetermined value.

11. A method according to claim 9 or 10, characterized in that it includes a step of applying a set of overlapping parameters to the projected segments ($S^{p}_{t+1,i}$) resolving the intersections between the adjacent projected segments ($S^{p}_{t+1,i}$).

12. A method according to any one of claims 9 - 11, characterized in that the step of segmentation of said first video frame (B_t) into segments ($S_{t,i}$) includes a step of applying a set of segmentation parameters contained in the video information and defining the segmentation process implemented for segmenting the first video frame into segments ($S_{t,i}$) during the compressing stage.

13. A computer program product for a data processing unit, comprising a set of instructions, which, when loaded into said data processing unit, causes the data processing unit to carry out the method claimed in any one of the preceding claims.

14. A device for compressing video information in a video sequence (I_t, I_{t+1}) comprising :

- means for segmenting the first video frame (B_t) containing image data into segments ($S_{t,i}$);
- means for searching, in a second video frame (I_{t+1}) following the first video frame (B_t) in the video sequence, a corresponding predicted segment ($S^{p,forward}_{t+1,i}$) which matches with the segment ($S_{t,i}$) of the first video frame (B_t) according to a predetermined similarity measure, for each segment ($S_{t,i}$) of the first video frame (B_t) ;

- means for calculating a raw set of motion parameters ($M^p_{t,i}$) describing the motion between the segment ($S_{t,i}$) of the first video frame (B_t) and the corresponding predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}), for each segment ($S_{t,i}$) of the first video frame (B_t) ;

- means for searching, in the first video frame (B_t), a corresponding segment ($S^{p,backward}_{t,i}$) that matches with the predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}) according to a predetermined similarity measure, for each corresponding predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}) ;

- means for calculating a best set of motion parameters ($M^p_{t,i} + \Delta M^p_{t,i}$) describing the motion between the corresponding segment ($S^{p,backward}_{t,i}$) of the first video frame (B_t) and the predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}), said best set of motion parameters consisting in the raw set of motion parameters ($M^p_{t,i}$) corrected by a motion parameter correction ($\Delta M^p_{t,i}$), for each corresponding predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}).

15. A device for decompressing video information in a video sequence (I_t, I_{t+1}) comprising :

- means for segmenting said first video frame (B_t) containing image data into segments ($S_{t,i}$);

- means for defining a projected segment ($S^p_{t+1,i}$) for each segment ($S_{t,i}$) of the first video frame (B_t), by applying to the segment ($S_{t,i}$) of the first video frame (B_t), a raw set of motion parameters ($M^p_{t,i}$) describing the motion between the segment ($S_{t,i}$) of the first video frame (B_t) and the corresponding projected segment ($S^p_{t+1,i}$) ;

- means for finding, in the first video frame (B_t), a corresponding improved segment ($S^b_{t,i}$) using both the raw set of motion parameters ($M^p_{t,i}$) and a motion parameters correction ($\Delta M^p_{t,i}$), the corresponding improved segment ($S^b_{t,i}$) being the segment of B_t that would be projected on the corresponding projected segment ($S^p_{t+1,i}$) by applying to it the raw set of motion parameters ($M^p_{t,i}$) corrected by the motion parameters correction ($\Delta M^p_{t,i}$), for each corresponding projected segment ($S^p_{t+1,i}$) ; and

- means for defining a corrected projected segment ($S^{p,o,c}_{t+1,i}$) by applying the raw set of motion parameters ($M^{p}_{t,i}$) corrected by the motion parameters correction ($\Delta M^{p}_{t,i}$) to the corresponding improved segment ($S^{b}_{t,i}$), for each corresponding projected segment ($S^{p}_{t+1,i}$).

16. Compressed data corresponding to a video sequence, characterized in that it has been obtained by a compression method according to any one of claims 1-8 applied on said video sequence.

Abstract

The invention relates to a method for compressing video information in a video sequence (I_t, I_{t+1}). According to the invention, this method comprises the steps of :

. segmenting a first video frame (B_t) into segments ($S_{t,i}$);

. for each segment ($S_{t,i}$) of the first video frame (B_t):

- searching, in a second video frame (I_{t+1}), a corresponding predicted segment ($S^{p,forward}_{t+1,i}$) which matches with the segment ($S_{t,i}$) of the first video frame (B_t) ;

- calculating a raw set of motion parameters ($M^p_{t,i}$) describing the motion between the segment ($S_{t,i}$) and the corresponding predicted segment ($S^{p,forward}_{t+1,i}$) ; and

. for each corresponding predicted segment ($S^{p,forward}_{t+1,i}$) :

- searching, in the first video frame (B_t), a corresponding segment ($S^{p,backward}_{t,i}$) that matches with the predicted segment ($S^{p,forward}_{t+1,i}$) of the second video frame (I_{t+1}) ;

- calculating a best set of motion parameters ($M^p_{t,i} + \Delta M^p_{t,i}$) describing the motion between the corresponding segment ($S^{p,backward}_{t,i}$) and the predicted segment ($S^{p,forward}_{t+1,i}$)

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Figure 2.

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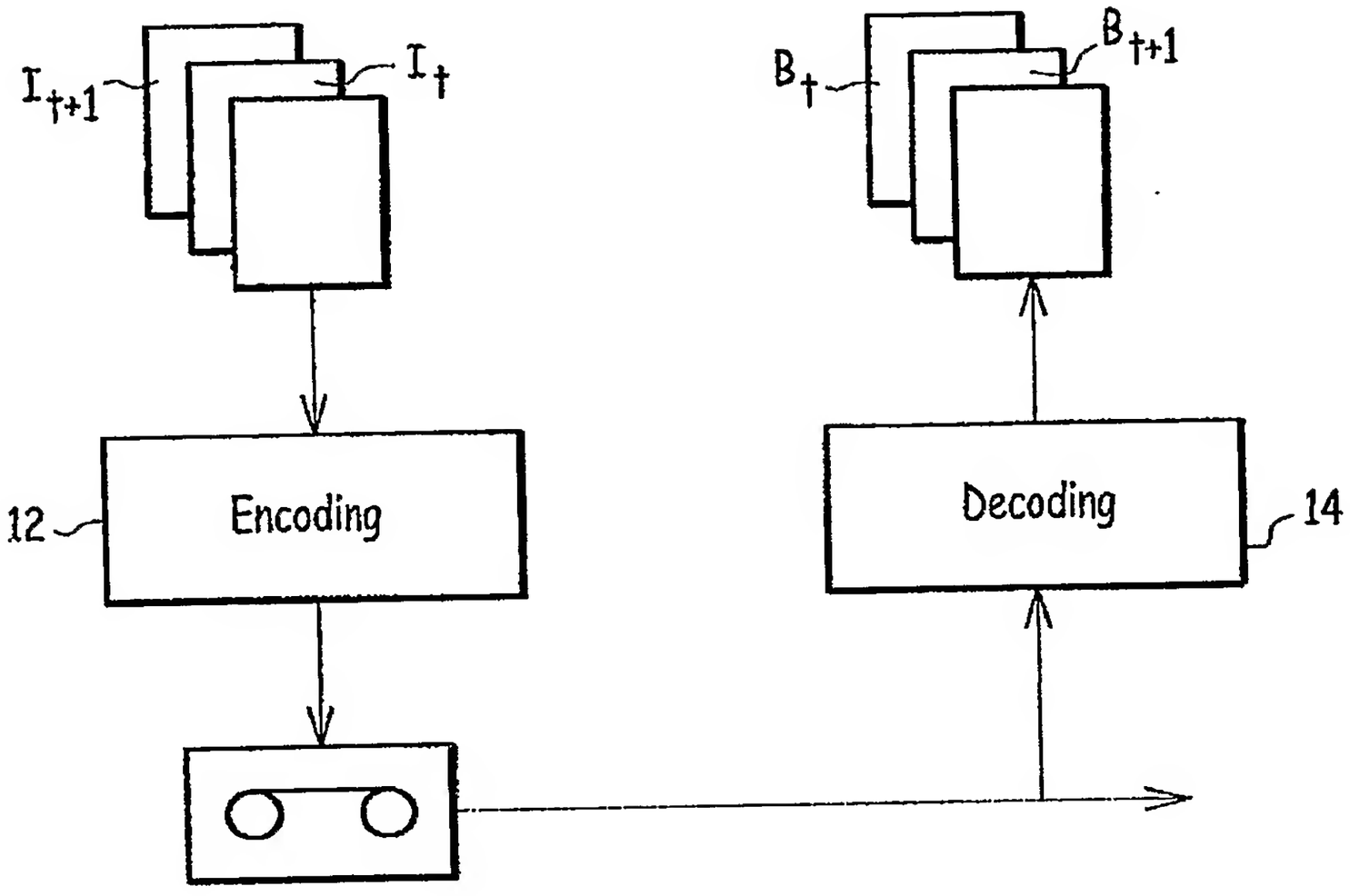

FIG.1

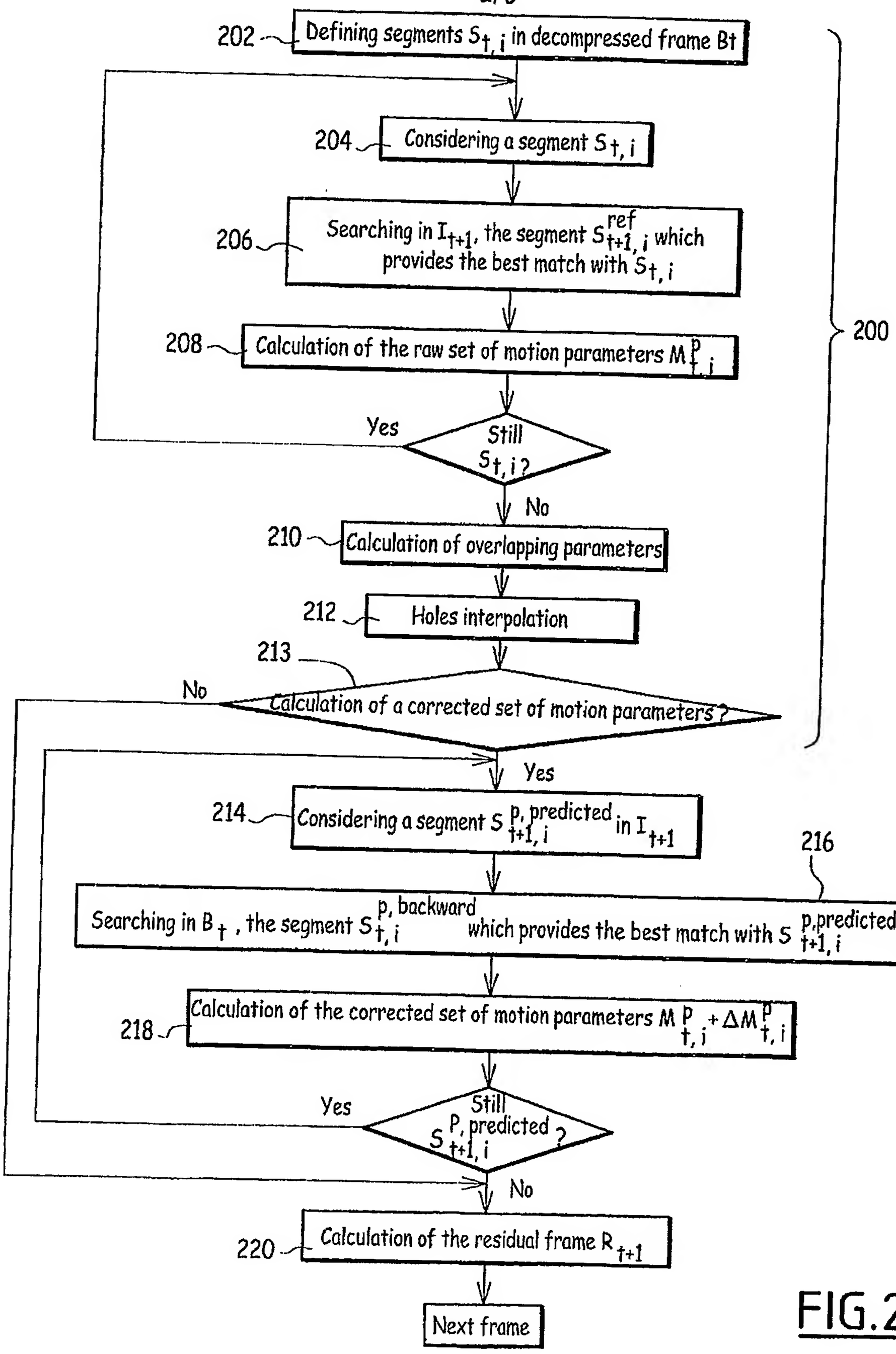
202
Defining segments $S_{t,i}$ in decompressed frame Bt
204
Considering a segment $S_{t,i}$
206
Searching in I_{t+1}, the segment $S^{ref}_{t+1,i}$ which provides the best match with $S_{t,i}$
208
Calculation of the raw set of motion parameters $M^{p}_{t,i}$
Yes
Still $S_{t,i}$?
No
210
Calculation of overlapping parameters
212
Holes interpolation
213
No
Calculation of a corrected set of motion parameters ?
Yes
214
Considering a segment $S^{p,predicted}_{t+1,i}$ in I_{t+1}
216
Searching in B_t, the segment $S^{p,backward}_{t,i}$ which provides the best match with $S^{p,predicted}_{t+1,i}$
218
Calculation of the corrected set of motion parameters $M^{p}_{t,i} + \Delta M^{p}_{t,i}$
Yes
Still $S^{P,predicted}_{t+1,i}$?
No
220
Calculation of the residual frame R_{t+1}
Next frame
200
201

FIG.2

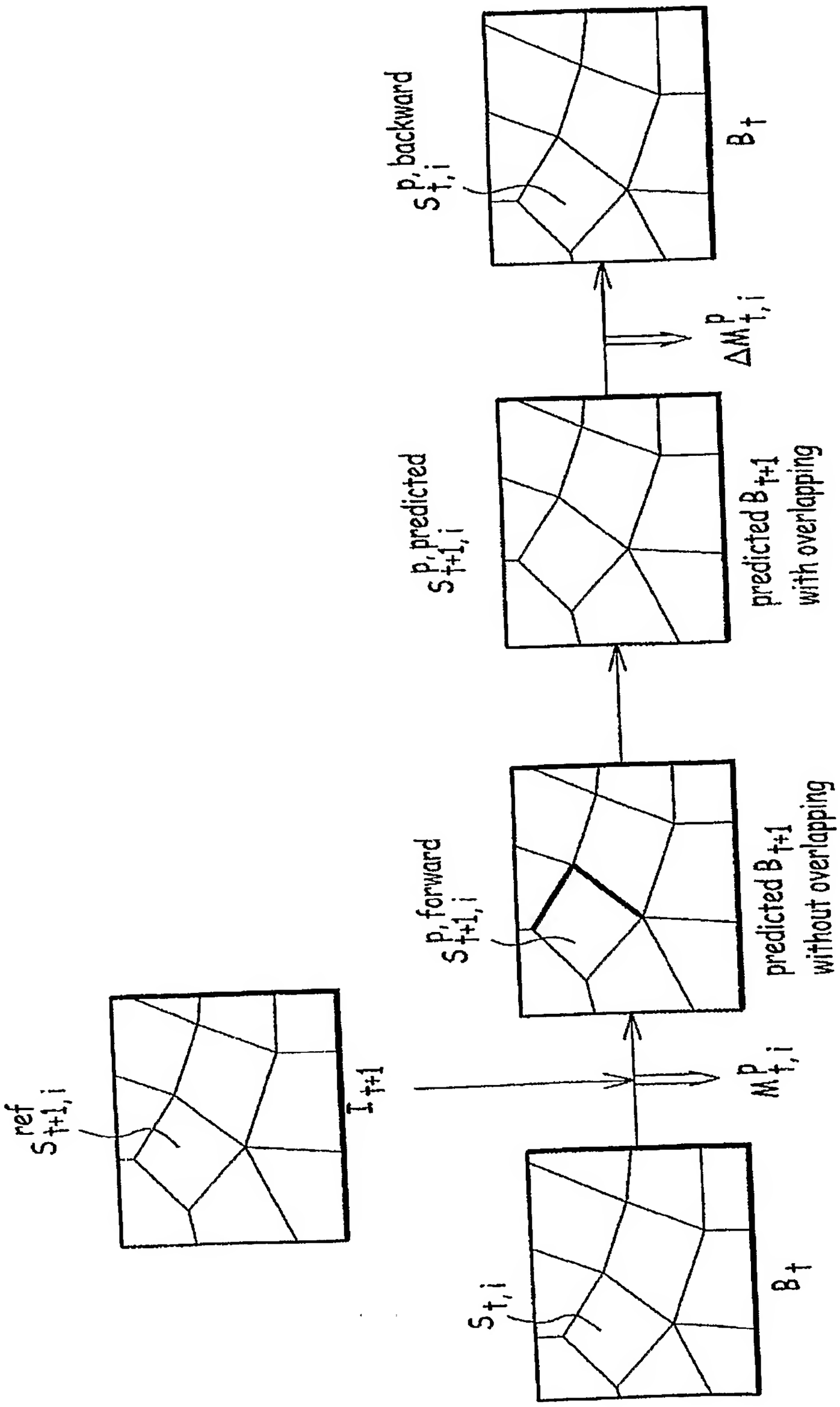
$s^{p,backward}_{t,i}$
B_t
$\Delta M^p_{t,i}$
$s^{p,predicted}_{t+1,i}$
predicted B_{t+1} with overlapping
$s^{p,forward}_{t+1,i}$
predicted B_{t+1} without overlapping
$s^{ref}_{t+1,i}$
I_{t+1}
$M^p_{t,i}$
$s_{t,i}$
B_t

FIG.3

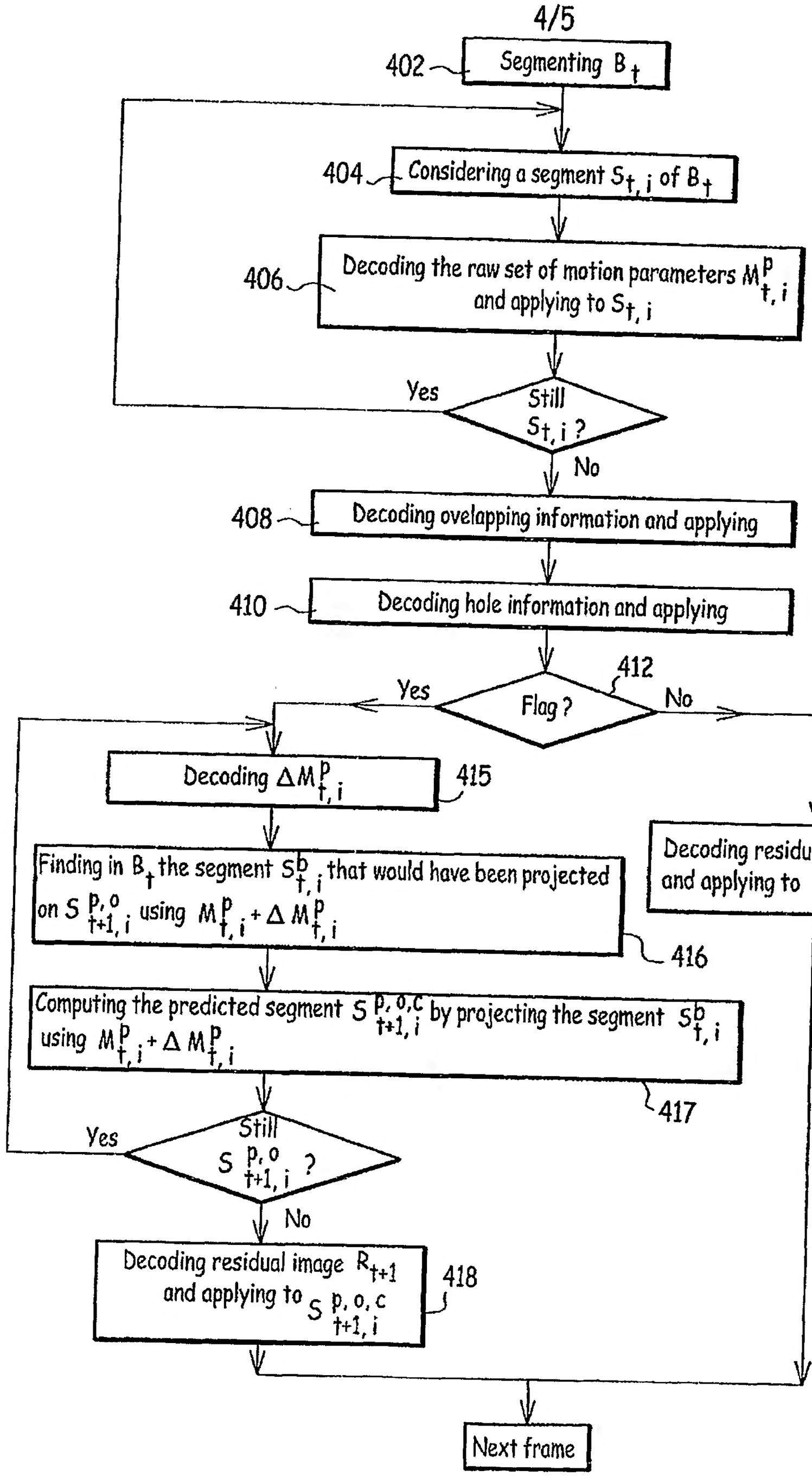
402
Segmenting B_t
404
Considering a segment $S_{t,i}$ of B_t
406
Decoding the raw set of motion parameters $M^p_{t,i}$ and applying to $S_{t,i}$
Yes
Still $S_{t,i}$?
No
408
Decoding ovelapping information and applying
410
Decoding hole information and applying
412
Flag ?
Yes
No
Decoding $\Delta M^p_{t,i}$
415
Finding in B_t the segment $S^b_{t,i}$ that would have been projected on $S^{p,o}_{t+1,i}$ using $M^p_{t,i} + \Delta M^p_{t,i}$
416
Decoding residual information R_{t+1} and applying to $S^{p,o}_{t+1,i}$
414
Computing the predicted segment $S^{p,o,c}_{t+1,i}$ by projecting the segment $S^b_{t,i}$ using $M^p_{t,i} + \Delta M^p_{t,i}$
417
Yes
Still $S^{p,o}_{t+1,i}$?
No
Decoding residual image R_{t+1} and applying to $S^{p,o,c}_{t+1,i}$
418
Next frame

FIG.4

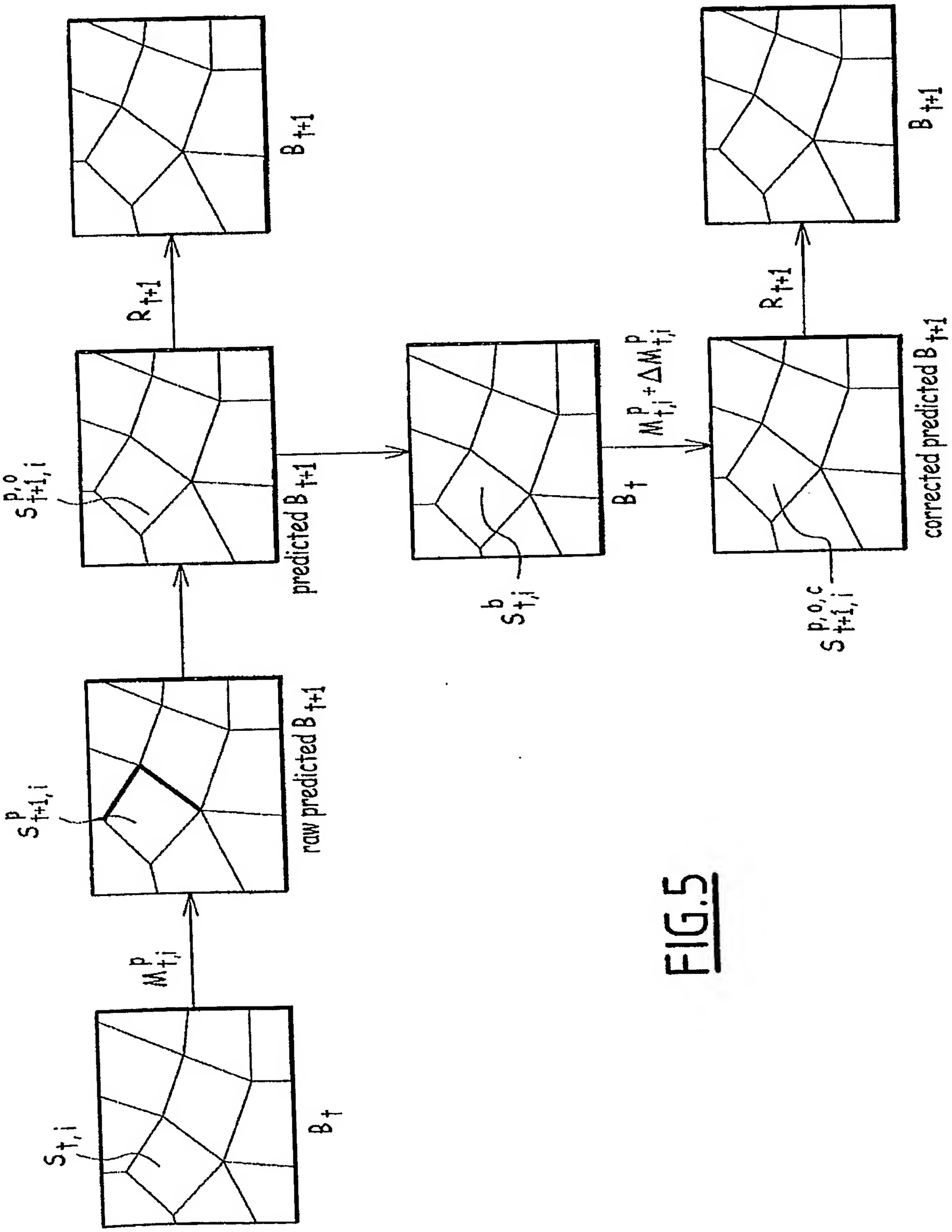
B_{t+1}
R_{t+1}
$S^{p,o}_{t+1,i}$
predicted B_{t+1}
$S^{b}_{t,i}$
B_t
$M^{p}_{t,i}+\Delta M^{p}_{t,i}$
corrected predicted B_{t+1}
$S^{p,o,c}_{t+1,i}$
$S^{p}_{t+1,i}$
raw predicted B_{t+1}
$M^{p}_{t,i}$
$S_{t,i}$
B_t

FIG.5

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